Abstract

Renewable energy sources are being integrated to existing grid because of environmental concerns with conventional sources and fast growing energy demands. Microgrid facilitates the easy integration of renewable sources and storage devices at distribution level to provide high power quality, reliability and efficiency. DC producing renewable sources, advancement of power electronic converters and compatible loads facilitate the concept of DC microgrid. Power electronic converters in DC microgrid cannot sustain high magnitude current and therefore, the current during fault is limited in the circuit. Current magnitude based protection schemes are not suitable for fault identification in DC microgrid.

Complete shutdown of DC microgrid for a fault removal by AC side protection is not acceptable because of the issue of system reliability and security. In this thesis, protection algorithms are developed using local and both ends data for DC microgrid. The proposed algorithms are capable to identify the internal and external faults correctly. A unit protection scheme for DC microgrid is proposed that uses superimposed currents of both ends of a line segment to derive protection decision. Another method is developed using oscillation frequency and associated transient power of the first cycle of oscillation for fault detection and faulted section identification respectively. Using local voltage and current data, a least square based technique estimates the parameter of the fault path, from which the direction of the fault is inferred to discriminate internal and external faults for network protection.

Accurate information on faulted section and fault location expedite the maintenance, fast restoration and reduce power outage duration. A method is proposed to identify the faulted section in DC distribution system using voltage and current data from consumer-end smart meters and the substation. A noniterative fault location technique using probe power unit is proposed. Considering damping frequency and attenuation of the probe current, which is a function of fault distance and damping coefficient, the fault location is obtained. The proposed methods are tested for different types of fault and fault resistances. Also, the performance of protection methods is validated using data from scaled-down laboratory setup.